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THE EXTRA-STRENGTH SEWER SURCHARGE
TO REGULATE
INDUSTRIAL SANITARY SEWER USERS

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ABSTRACT

The extra-strength sewer surcharge (ESSS) is a charge levied against industrial users of sanitary sewers by municipal sewerage authorities as a result of the excessive strength of their wastewater discharge. This study investigates the ESSS as one of the potential mechanisms that could be promoted to control industrial sanitary discharges under the Ontario Ministry of the Environment's Municipal - Industrial Strategy for Abatement (MISA) initiative.

The study methodology includes a thorough literature review, a major national survey of municipalities in Canada, interviews with municipal staff involved in ESSS programs in Ontario and economic analyses of surcharge rates, municipal treatment costs and industrial pretreatment costs. Survey and interview data were compiled and, together with literature findings and economic analyses, were used to evaluate the advantages and disadvantages of ESSS programs. This evaluation focuses on treatment cost allocation effects, inducements for industrial pretreatment, municipal revenue impacts, impacts on municipal treatment facilities, and administrative implications. Recommendations are provided regarding implementation of ESSS programs.

INTRODUCTION

In June of 1986, the Ontario Ministry of the Environment announced the Municipal-Industrial Strategy for Abatement (MISA). The goal of MISA is the "virtual elimination of toxic contaminants" that are being discharged to surface waters by municipalities and industry (MOE, June 1986). This goal is to be achieved through the development and promulgation of regulations containing monitoring requirements and effluent limits.

The problem of industrial discharges into municipal sewage treatment plant systems was identified during the public review process as requiring greater attention by the program. The Ministry of the Environment is currently developing a Sewer Use Control Program intended to reduce industrial toxic discharges to sewer systems. The Sewer Use Control Program will include legislative amendments, implementation activities, enforcement mechanisms. The proposed program calls for the Ministry of the Environment to set province-wide discharge limits on toxic contaminants from industrial sewer users.

The extra-strength sewer surcharge (ESSS), which is the subject of this study, is one element of the proposed Sewer Use Control Program. The ESSS is a charge paid by industrial users of sanitary sewers which increases as the concentration of targeted contaminants in their waste water increases beyond a designated level. The ESSS can provide revenues to offset costs of treating industrial wastes in municipal plants. More importantly, ESSS charges can give sewer users an economic incentive to reduce their wastewater loadings.

The Model Sewer Use Bylaw revised in 1987 by the Ministry of the Environment has provision to enable a municipality to implement a sewer surcharge program for certain specified parameters (MOE, August 1988). Only five conventional pollutants would be allowed for surcharge agreements under the proposed Sewer Use Control Program: suspended solids, biochemical oxygen demand, solvent extractable matter of animal and vegetable origin, nitrogen, and phosphorous.

OBJECTIVES OF THIS STUDY

Past studies have examined the ESSS and other regulatory mechanisms to control pollution (Peat, Marwick and Partners, July 1983; Donnan and Victor, 1974). These studies provide some evidence regarding the efficacy of the ESSS but they do not document the extent to which ESSS programs are implemented in Ontario or Canada and they are not detailed enough to permit an evaluation of the ESSS as an economic incentive mechanism within MISA (Ministry of the Environment, 1987).

The goal of this paper is to contribute to the evaluation of sewer use control options by providing a detailed description and critique of the use and effectiveness of ESSS programs in Canada.

STUDY METHODOLOGY

An extensive literature search was conducted using bibliographic databases available through the Industrial and Business Information Service of the University of Waterloo. Phone interviews were conducted with provincial agency staff across the country. Following this, a questionnaire survey was sent to the engineering or works department of municipalities throughout Canada, with 5,000 or more people and which provide municipal sewage collection and treatment services (referred to herein as the "National Survey"). This amounted to 546 municipalities with a total population of 14.1 million or 64% of Canada's 1986 population. A total of 192 completed questionnaires were returned from respondents representing municipalities with a total serviced population of 10.5 million people. From among the questionnaire survey respondents, six Ontario municipalities were selected for follow-up interviews to collect detailed information on compliance (referred to herein as the "Municipal Interviews"). In addition, to the primary data collection efforts noted above, secondary data sources on treatment costs were used in an economic analysis of surcharge programs.

OVERVIEW OF THE ESSS

Charges for the use of sanitary sewers include various mechanisms such as flat fees, tax levies, fees based on the volume of water consumed or discharged and fees based on the pollutant concentration. Such charges are used to recover the costs of collecting and treating sanitary wastes. The practice of charging for sewage services goes back to the turn of the century in the United States (Lake, Hanneran and Oster, 1979) and the United Kingdom (Harkness, 1984).

In the United Kingdom, charges for industrial effluents were initially set to be proportional to discharge volume. In 1936, with the opening of the Modgen Works treatment plant in West Middlesex, an effluent charge based on both quantity and quality was introduced (Ingold and Stonebridge, 1987). By 1976, existing ESSS practices of various local authorities were codified as national guidelines for sewer use and for charges related to industrial effluents. British Regional Water Authorities now control virtually every industrial effluent discharged to sanitary sewers in Britain and can impose charges that are set to recover "the actual cost of reception and treatment of industrial effluent" (Sidwick, 1982).

While there is not the same degree of centralization and standardization in the United States as is evident in the United Kingdom, certain requirements and charges for industrial effluents are nevertheless promoted at the federal level by 1972 amendments to the Clean Water Act. According to Taylor (1972), the objectives of regulations under this act are:

- to distribute costs in proportion to benefits received;
- to assure financial capability to construct and operate facilities;
- to promote awareness of treatment costs;
- to promote volume and loading based costs; and
- to encourage self-sufficiency in sewage services.

Surveys that predate the amendment found that 20% of the reporting U.S. cities had provisions for an ESSS in their bylaws while less than 10% had actually implemented an ESSS (Public Works Engineer, 1955; Lake, Hanneman and Oster, 1979). In a more recent survey, two thirds of respondents were found to be using an ESSS (Technical Practice Committee, 1982).

While there exist significant variations in programs across national boundaries and across municipalities, all ESSS programs have certain basic features in common, namely;

- a formula for determining the total charge per unit time which identifies chargeable waste water constituents and associated charge rates;
- criteria for determining which firms are to be charged; and
- a means of assigning waste strength values to industrial discharges for purposes of charging.

APPLICATION OF EXTRA-STRENGTH SEWER SURCHARGE IN CANADA

Of the 192 respondents to the National survey, 33 reported having an ESSS program "in the books." This number represents 17% of the reporting municipalities. The communities which say they had ESSS programs are concentrated in Ontario and the Prairies, as shown in Table 1. However, of the 33 municipalities with ESSS programs, 26 had implemented monitoring and enforcement with eligible industrial sewer users (15 of these were in Ontario) municipalities have a total population of 6.2 million.

TABLE 1
USE OF AN EXTRA-STRENGTH SEWER SURCHARGE PROGRAM
BY QUESTIONNAIRE RESPONDENTS

JURISDICTION	MARITIMES	QUEBEC	ONTARIO	PRAIRIES	BR. COL.	CANADA
Number of Responding Municipalities						
Total number responding	10	25	94	40	21	192
Mun's with program in place ¹	1	1	15	14	2	33
(% of total)	10.0%	4.0%	16.0%	35.0%	9.5%	17.2%
Mun's with program implemented ²	0	1	15	8	2	26
(% of total)	0.0%	4.0%	16.0%	20.0%	9.5%	13.5%
Service Population of Responding Municipalities						
Total for all municipalities	64,340	263,520	8,220,500	1,394,430	541,550	10,499,330
For mun's with program in place	15,000	38,000	4,850,400	1,217,250	54,200	6,174,850
(% of total)	<23.3%	14.4%	59.0%	87.3%	10.0%	58.8%
For mun's with program implemented	0	38,000	4,850,400	1,216,810	54,200	6,159,410
(% of total)	0.0%	14.4%	59.0%	87.3%	10.0%	58.7%

NOTES: ¹ Counts based on numbers of municipalities who provided information describing their ESSS programs (questions in Section 3A and 4, Appendix B questionnaire form)

² Counts based on numbers of municipalities who reported monitoring and charging activity under an ESSS program (questions 45 and 46, Appendix B questionnaire form)

SOURCE: Extra Strength Sewer Surcharge Municipal Survey

In a recent survey by LeClair (personal communication, B. LeClair, MOE 1988), 45 out of 78 reporting municipalities in Ontario indicated provisions for surcharging industrial users in their respective bylaws. Of these 45, it would appear from results of the National Survey that only 14 had implemented industrial monitoring activities and actual surcharges. Similarly, Lake, Hanneman and Oster (1979) found that, in survey of 1,160 U.S. municipalities, 20% allowed for surcharges in their bylaws but only 5% actually measured discharges and levied surcharges.

Municipalities reporting a surcharge program form a distinct subset of reporting municipalities. Secondary or tertiary treatment systems are used by 88% of these municipalities as opposed to 55% of those not using the ESSS. Municipalities with the ESSS also tend to have a larger service population with more industrial accounts; and, in fact, encompass 59% of the total reported service population though representing only 17% of reporting municipalities. The proportion of industrial establishments that are within jurisdictions using an ESSE is likely to be most closely reflected by the service population data. If this is the case then the data suggest a relatively high exposure of industry to the ESSS within our survey sample.

PROGRAM IMPLEMENTATION

The initiation of ESSS programs usually engenders opposition from industrial users in anticipation of higher costs. This opposition can be overcome during the implementation period. For instance the average program design and implementation period among questionnaire respondents lasted 17 months with industry being given almost a year of lead time to allow plant managers to adjust operations prior to being charged. In Greenboro, N.C., this adjustment was facilitated by municipal staff who assisted firms in this adjustment stage (Shaw, 1970).

In half of the reporting municipalities, an information program was mounted for industry to introduce the program and input was solicited from industry. Bubbis (1963) and Mount (1979) concluded that good communication with industry during program implementation may be worth the delays and other costs that result.

PROGRAM OBJECTIVES

Two thirds of respondents identified the fair allocation of treatment cost as their key objective. In this context, a fair cost allocation means that costs are allocated to users or user groups in proportion to the sewage treatment services received. This is consistent with the user-pay pricing principle supported by the Inquiry on Federal Water Policy (Pearse, Bertrand, Maclaren, 1985).

The survey results also showed that many municipalities (21 out of 30) implemented ESSS programs in order to induce pretreatment by sewer users. However, there was very little interest expressed in revenue generation as a motive for ESSS programs (4 respondents out of 30).

ESSS AS PART OF AN OVERALL REGULATORY STRATEGY

Over one third of respondents (13 out of 30) said that the ESSS charge was a penalty for high strength wastes. The focus on regulation was also encountered during follow-up interviews with municipal staff. For example, the Regional Municipality of Peel, set the elimination of extra-strength discharges within five years as an explicit goal. That nine out of 32 respondents reported expanding bylaw enforcement efforts while introducing the ESSS is further evidence of the regulatory motivation behind ESSS programs.

Apart from the ESSS, mechanisms reported for sewer use regulation include bylaw limitations on waste strength supported by a program of surveillance and enforcement sanctions. Bylaw limits must be found to be exceeded one or more times during surveillance before enforcement action commences. On average, respondents to the National Survey indicated that just under four violations are required to trigger enforcement action.

Municipalities with ESSS programs in place tend to have a more extensive general program of industrial regulation. For instance, only 15% of municipalities with an ESSS program report no program for detection of bylaw violation while over 40% of those without the ESSS have no such program. Similarly, a greater number of municipalities with the ESSS report use such mechanisms as negotiations, warnings and prosecution to enforce bylaw limits when violations are detected. "Other" enforcement mechanisms that were reported include severance of service and invoicing users for extraordinary costs incurred as the result of receiving high strength wastes.

The more active regulatory stance of municipalities which have an ESSS is also reflected in the intensity of surveillance efforts to detect bylaw infractions. On average they monitor one firm out of every 3.4 industrial clients on their systems. In communities without an ESSS, one out of every 26.6 industrial clients is monitored.

ESSS PROGRAM COVERAGE

Municipalities have devised various methods or rules for identifying who is eligible for charging under the ESSS. These methods include:

- coverage of all industrial dischargers,
- establishing thresholds in terms of a minimum wastewater concentrations or volumes,
- defining eligible industrial sectors.

In Winnipeg, for example, establishments in 16 key industries have their discharge monitored by the city (Perman, 1974). Large sources are treated

in a similar manner in Greenboro, N.C., but smaller industrial sources, such as laundries, are also brought into the ESSS program with charging of these based on representative waste strengths for classes of dischargers (Shaw, 1970). Both New York City and Los Angeles County also include classes of smaller dischargers and assume representative waste strengths for clients in these classes (Anonymous, 1971; Kremer and Glasgow, 1979).

For program coverage to be based on wastewater strength or on membership in a high waste strength industrial sector, there is usually a threshold for contaminant concentration below which waste strength is considered acceptable. Los Angeles County does not use such a threshold in its charge program; neither does Chicago (Anderson and Sosewitz, 1971). In the absence of a lower threshold, all industrial dischargers are eligible for ESSS charging. Chicago sets a discharge volume threshold, instead of a concentration threshold, below which the ESSS does not apply. Dischargers of small volumes are exempt from surcharges if a volume threshold is in place.

DETERMINING WASTEWATER STRENGTHS

Wastewater strength can be determined from monitoring data, or, where no monitoring is done, representative values for industrial sectors can be assumed. Twenty-five of 31 respondents to the National Survey rely entirely on monitoring, while only one uses representative data and five use both.

In 32 out of 33 reported cases the municipal sewage authority is responsible for sampling. Dischargers engage in sampling in 6 municipalities. In 16 out of 21 cases auditing of sample results is done by the municipality. In Windsor, municipal samples are split in certain cases to allow firms to verify municipal laboratory results.

PROGRAM SIZE

A total of 400 firms are monitored under ESSS programs covered by the survey, or an average of 12 per municipality. In 15 cases, 10 or fewer firms are monitored, in 3 cases more than 30 are monitored and the maximum number in any one program is 84 in Metro Toronto. On average, a surcharge fee is levied against 87% of the monitored firms. Half of the respondents charged all the firms that were being monitored in their programs.

RATE STRUCTURE

Charges for extra-strength sewage are usually calculated as a charge rate multiplied by discharge flow volume over the billing period and a factor based on the strength or concentration of chargeable parameters in the wastewater. Measures of waste water concentration used in the ESSS formula may be:

- the actual concentration of the wastewater,
- the excess concentration estimated as the actual minus an

allowable or "threshold" concentration (set to zero if this difference is negative),

- the ratio of actual and threshold concentrations, or
- the ratio of excess and threshold concentrations.

Where more than one parameter is included in a rate formula, so-called "apportionment factors" are applied as coefficients by which each parameter is multiplied. Apportionment factors provide for the allocation of the charge rate across the chargeable pollutants included in the surcharge formulae. Details on surcharge formulae were reported by 31 respondents. The 31 formulae included at least one, and usually 2 or more of the following pollutant parameters:

- BOD (biological oxygen demand)
- SS (suspended solids)
- grease and oil

Other parameters reported by 6 of the 31 respondents were phosphates, phenols and COD (chemical oxygen demand). The majority of respondents (over 70%) used threshold concentrations for BOD and SS ranging from 300 to 500 mg/l. The bylaw limits for these two parameters never fell below the threshold concentration used in the ESSS formulae.

The following formulae are representative of the different types used by the responding municipalities:

Waterloo Region, Ontario:

$$\text{ESSS} = Q \times (\$.40/1000 \text{ gal.}) \times [\text{A.F.}(\text{BOD}-300)/300 + \text{A.F.}(\text{SS}-350)/350 + (\text{phenol}-1)/1]$$

[where: A.F. = apportionment factor = 0.5]

Regina, Saskatchewan:

$$\text{ESSS} = Q \times [\$0.031(\text{BOD}-300) + \$0.031(\text{SS}-300) + \$0.027(\text{grease}-100) + \$0.060(\text{PO}_4-30)]$$

Swift Current, Saskatchewan:

$$\text{ESSS} = Q \times [\$0.042(\text{BOD}) + \$0.011(\text{SS}) + \$0.046(\text{grease})]$$

In these formulae, Q represents total wastewater discharge volume over the billing period while BOD, SS, grease and PO_4 indicate measures of actual wastewater strength. The charge rates applied to the various parameters are reported to be based on collection and/or treatment system costs. In some municipalities, rates also cover ESSS program costs or are based on revenue targets.

Charge rates for BOD range from \$0.032 to \$0.77 per kilogram, \$0.011 to \$4.42 per kilogram for SS and from \$0.024 to \$ 15.50 per kilogram for grease and oil. Of the two municipalities that levy charges for phenol,

one charges \$0.233 per kilogram while the other charges \$87.90 per kilogram. Some smaller municipalities negotiate ESSS payments directly with the industrial or commercial sewer users rather than using standard formulae.

In the National Survey, reported surcharge billings to individual establishments averaged \$6,800.00 per quarter, ranging from \$2,000.00 to \$7,500.00.

In the survey and follow-up interviews it was found that more complex surcharge formulae deter municipal staff who have to administer the program. In one instance, this antipathy resulted in a surcharge formula being dropped in favour of a fixed annual fee negotiated with each company. Sewer users were also reported to have complained about complex formulae.

DETERMINATION OF SURCHARGE RATES

Perhaps the most complex technical task in setting surcharge rates is the apportionment of collection and treatment system component costs to each chargeable parameter. Charge rates are typically based on average unit costs for treatment. If there is only one chargeable parameter, say BOD, then the charge rate for BOD would be based on total treatment costs divided by total BOD load. With additional parameters, this simple measure of average unit cost, if applied to each parameter, would not be appropriate since it would result in charging of treatment costs several times over. Rather, total treatment costs must be apportioned to each of the chargeable parameters using factors that account for all costs

without at the same time leading to double counting of costs. The issue of how cost apportionment factors are derived is important since the basis for cost apportionment can have a significant impact on the charge faced by individual firms (Foess and Myrhier, 1983).

The most frequently encountered ESSS formula is one requiring the apportionment of costs among discharge flow, BOD and SS. There are different treatments of this case documented in the literature which place varying emphasis on system design and system function in deciding the apportionment. A representative apportionment is provided by Ingold and Stonebridge (1987).

Flow related costs - conveyance	
	- primary treatment
BOD costs	- biological treatment
SS costs	- sludge treatment and disposal

Specific apportionments will vary depending on whether capital or operating costs are involved, on the treatment system configuration, and on the judgement of the engineer doing the analysis. The underlying difficulty with this sort of cost analysis is that the particulate fraction of BOD and the biodegradable fraction of SS are closely associated constituents of sewage that are jointly removed at different stages of the treatment process. Treatment costs for these constituents cannot, strictly speaking, be logically differentiated and any apportionment will always be somewhat arbitrary and subject to debate.

Moreover, any apportionment can introduce a degree of inequity into the charge in that industrial effluents have varying mixes of dissolved vs. particulate BOD and biodegradable vs. inorganic solids. The cost burden associated with different types of effluent will therefore vary and may not be accurately reflected in the ESSS charge rates for BOD and SS

In light of the complexity and uncertainty inherent in the cost apportionment exercise it is not surprising that National Survey responses concerning how costs are apportioned showed no clear pattern; the basis for cost allocation being:

System design considerations	- 3 respondents
Treatment system function	- 3 respondents
Design and function	- 6 respondents
Arbitrary 50/50 split	- 2 respondents
Other criteria	- 4 respondents

In the "other" category, detail was only provided for two cases in which a single cost factor was estimated and then applied to BOD or SS whichever is greater.

ECONOMIC EFFICIENCY AND ESSS RATES

Economic efficiency is often interpreted as achieving a cost-effective outcome, or in the context of this study, a least cost combination of industrial pretreatment and municipal treatment in order to attain a given level of final effluent quality.

However, economic efficiency has a broader interpretation in economic theory than cost-effectiveness; the benefits of water quality protection are considered as well as the costs of treatment. In a benefit cost framework, economic efficiency requires that wastewater treatment be provided up to the level at which the value of resulting water quality benefits are judged to be commensurate with the extra costs. Benefits may accrue to the firm or agency which incurs the expense if cost reductions or extra revenues are achieved. However, the impacts of water quality improvements are more likely to benefit the public. Agents who incur the costs of these improvements seldom realize any direct benefits and may accordingly perceive these costs as an unwarranted burden. Nevertheless, these public benefits are very real to society and should be included in public decision making.

Public benefits can often be quantified in appropriate biophysical units and/or dollar values although certain types of water quality benefits are much more difficult to evaluate.

Municipalities are not in a position to balance wastewater treatment costs against associated public water quality benefits because water quality and effluent objectives are determined by Provincial authorities. Under

prevailing regulatory procedures, municipalities are only responsible for achieving mandated water quality and effluent objectives in a cost-effective manner; accordingly, cost-effectiveness is used here as the basis for discussing economic efficiency.

Marginal costs are the incremental costs of production that are caused by incremental changes in the level of production activity. In the context of the ESSS, marginal costs should be measured as the change in operating and capital costs that occur in conjunction with increases in strength of the incoming sewage to a treatment plant.

Marginal costs provide a basis for setting ESSS charge rates that will promote economic efficiency. For example, the marginal cost of installing a phosphorus (P) removal system at a municipal treatment facility was estimated to be in the range of \$3 to \$10/kg P removed. Any industrial or commercial sewer user who wishes to minimize costs will choose to pay a surcharge if pretreatment costs per kg P exceed the ESSS charge. Otherwise, pretreatment will be adopted as the lowest cost option. When an ESSS charge rate for P is set based on the municipal marginal cost, P removal will then be achieved using the least-cost method whether that be by treatment at source or at the municipal plant.

It follows from economic theory that ESSS rates should be based on the marginal cost of providing the service. Where marginal costs can be estimated with some ease, as in the case of phosphorus removal, the excess chlorine demand of effluents (Olliffe, 1963), or the costs of removing grease accumulations in collectors, rates can be set on this basis.

However, separate marginal costs associated with BOD and SS removal at municipal plants cannot easily be estimated because these parameters are removed simultaneously by treatment systems. Moreover, experience has shown that the costs of operating a municipal sewage treatment plant for BOD and SS removal will depend primarily on flow. Variations in wastewater inflow strength which are within the treatment system design specifications will have a negligible impact on operating costs. Consequently, the marginal costs of incremental changes in BOD or SS loadings to the treatment plant are negligible when the plant is operating within its design capacity.

In addition to the direct or "private" costs of building and operating sewage treatment plants, environmental damages caused by pollutants which are borne by downstream users or by natural ecosystems should also be considered as part of the cost of operating the sewage treatment plant. The reduction of these damages constitutes the public benefit associated with water quality protection. Environmental damages are called "public" or "indirect" costs. If both direct municipal as well as public costs associated with a treatment plant are to be considered in setting ESSS rates, the rates would be higher than if only direct municipal costs were considered.

Imposition of higher ESSS rates than these indicated by extra treatment costs may be justified on the basis of collecting funds to pay for environmental rehabilitation or even compensation to damaged parties. However, municipalities have no incentive to add environmental damage costs to their surcharge rates unless fines, penalties, or other charges were imposed by the Province on the municipality.

INCENTIVE EFFECTS

ESSS charges can give industrial establishments a powerful incentive to implement pretreatment when the cost of pretreatment is less than the cost that would otherwise be incurred as an ESSS charge. However, decisions by plant managers regarding pretreatment of industrial sanitary discharges will be governed by a range of other factors such as:

- legal and financial implications of not pretreating
- availability of plant labour to operate a treatment system,
- nuisance caused by the treatment system, and
- availability of land to install systems.

Pretreatment costs were estimated for 28 industrial establishments for which data were collected during the municipal interviews. Estimated pretreatment costs are then compared to surcharge rates to determine if the ESSS charges actually provide an economic incentive to adopt pretreatment.

Total estimated pre-treatment capital costs for the 28 sample firms averaged \$2.4M and ranged from \$0.4M to \$6.2M. Total annual operating and maintenance costs averaged \$1.07M, ranging from \$0.125M.

In contrast, annual surcharge payments by these firms averaged \$74,400 and ranged from \$15 to \$372,700. These surcharges amount to only 9% of estimated operating and maintenance costs on average, and at the maximum, were only 43% of estimated pretreatment operating and maintenance costs.

Consequently it would appear cheaper for the affected firms to pay the ESSS than to install pretreatment. This conclusion was confirmed when estimated pretreatment operating and maintenance costs were compared to surcharge rate levels reported in the National Survey. The average ESSS rate, expressed as dollar per kg BOD discharged, was \$0.264, ranging from \$0.032 to \$0.770. All of the reported ESSS rates were less than the estimated unit pre-treatment operating and maintenance costs for the 28 individual establishments which ranged from \$1.15 to \$38.71 and averaged \$8.02/kg BOD removed.

In comparison, municipal treatment costs per unit of removal are considerably lower than industrial pretreatment costs (Table 2). This is the expected result given the economies of scale inherent in the abatement technologies considered in the analysis. Based on this assessment, pretreatment for BOD, and suspended solids is in fact cost effective only where large establishments discharge effluents to small municipal facilities. Otherwise, centralized treatment of BOD and suspended solids in municipal sewage treatment plants is more cost-effective. However, other contaminants such as metals and toxic organic compounds may not be amenable to removal by conventional municipal sewage treatment systems. To induce pretreatment in such cases surcharges would have to be high enough to make pretreatment or at-source removal of the contaminants less costly than payment of the surcharge.

INDUSTRIAL RESPONSE TO THE ESSS

Despite the conclusion above that ESSS charge rates are often lower than pretreatment cost rates, the survey results revealed that industrial establishments which were subject to surcharges responded by improving housekeeping practices, changing production practices to reduce flows, analyzing waste flows to verify the surcharge and installing pretreatment. Eight of the 31 firms which were discussed during follow-up interviews with municipal authorities had installed pretreatment facilities.

Table 2

MUNICIPAL COST FOR BOD REMOVAL IN MUNICIPALITIES WITH ESSS PROGRAMS (1987 \$/KG BOD)

	MAXIMUM	AVERAGE	MINIMUM
100% Apportionment of Costs to BOD	\$3.77	\$0.75	\$0.39
50% Apportionment of Costs to BOD	\$1.89	\$0.38	\$0.20
25% Apportionment of Costs to BOD	\$0.94	\$0.19	\$0.10

Source - Interpreted from National Survey Data.

These responses could not have been motivated entirely by economic considerations if ESSS charges are generally lower than the cost of effluent pretreatment systems. It is possible that other regulatory pressures help to induce the decision to install pretreatment with the economic incentive provided by the ESSS being a secondary consideration. It is also likely that many of the actions taken by industry to reduce wastewater strength comprise low-cost measures that are economically justified by ESSS charges. The pretreatment costs discussed above do not consider such measures. Whatever the reason, it is apparent that the ESSS has an impact. Nineteen out of 29 municipalities with ESSS programs reported such consequences as reduced loadings of SS, BOD and other contaminants, reduced operating costs, reductions or delays in capacity expansion, or changes in hydraulic loadings.

ESSS PROGRAM COSTS AND REVENUES

Although revenue generation was not cited by survey respondents as a major program objective of the ESSS, municipalities have benefitted financially from ESSS's. Total annual ESSS revenues collected by 24 municipalities which responded to revenue questions in the National Survey amounted to \$9.1M; an average of \$380,000 per municipality.

Based on responses from 18 municipalities, ESSS program activities required an average of 4.3 person-years of effort each year. An annual average of 260 samples were analyzed in each ESSS program. Assuming a staff salary level of \$30,000 per year and an analysis cost of \$80.00 per sample (based on commercial lab prices for the relevant tests), ESSS programs appear to cost about \$150,000 per year; well under the reported average annual revenue figure.

PREFERRED DESIGN FEATURES OF ESSS PROGRAMS

Several important design features of ESSS programs were identified. These design features must be considered in developing new ESSS programs.

For example, an ESSS program, if adopted, should be applied to all industrial sewer users which discharge the relevant contaminants. Broad coverage can be achieved if representative waste strengths and volumes are assigned to each industrial sector which discharges into the system.

An ESSS program should be kept simple and straight forward. One way of doing this is to limit charges to parameters for which there is wide agreement on measurement such as BOD (or COD), suspended solids, grease and oil and, perhaps, phosphorous and phenols.

ESSS charges should be linked to identifiable costs at municipal sewage treatment plants. The ESSS rates should be based on the extra treatment and handling costs incurred at municipal sewage treatment plants which are associated with excess loadings of the wastewater constituents in question. These charges will induce industrial sewer users to install pretreatment when they are commensurate with the capital and operating costs of pretreatment systems.

While there is considerable variation in rate structures from one municipality to another, the more frequently encountered rate structures are those in which the charge applies to the entire pollutant load or to a measure of excess load. The former approach is desirable in that it gives polluters an ongoing incentive to reduce pollutant loadings. Application of the charge rate to the entire loading will also eliminate the incentive to dilute effluents with clean water in order to reduce concentrations below a threshold (Sims, 1979).

Program implementation should involve municipal interaction with industrial establishments in order to explain the purpose of the program and provide opportunities for feedback from affected sewer users. A transition period of about 12 months is often provided during which sewer users have time to adapt to the new system and reduce their discharges before the ESSS charge comes into effect.

SUMMARY

Of the 192 respondents to the Canada-wide survey, 33 reported having an extra-strength surcharge program "on the books." Of these, 26 had implemented the program to the extent that industrial dischargers were being monitored and surcharges levied on occasion. The survey has identified virtually all of the municipalities in Canada with an active extra-strength sewer surcharge program.

Existing ESSS programs in Canada are generally located in larger urban centers where problems arising from industrial wastes in sewers are more prevalent. The programs focus on industrial establishments which are large and discharge large volume, high strength wastes. Surcharges have been established for BOD (or in some cases, COD), suspended solids, grease and oil and, in a few instances, phenols or phosphates.

Survey results show that ESSS programs have been effective in spurring dischargers to install pretreatment and to control the strength and flows of industrial dischargers to municipal sewer systems.

ESSS programs are also viewed by many municipalities as a means of equitably recovering the extra costs of treating industrial and commercial wastes in municipal sewage treatment plants.

Simple, easy to understand surcharge formulae are most preferred by municipal authorities as well as by firms who pay surcharges.

RECOMMENDATIONS

The following recommendations follow from this study:

- A model sewer-use bylaw should include provisions and guidelines for a municipality to enact and implement an ESSS program. The decision to implement an ESSS program can then be based on local conditions.
- If an ESSS program is to be effective at inducing sewer users to install pretreatment, surcharges must be commensurate with the direct capital and operating costs of the pretreatment technologies.
- A periodic sewer-use rate survey should be conducted by provincial authorities to inform interested parties about ESSS practices and to facilitate municipal ESSS program planning exercises.
- Further study of the feasibility, removal efficiencies and cost pretreatment and centralized treatment technologies relevant to toxic constituents should be initiated in order to determine the utility of ESSS charges for these constituents.

Together with more extensive monitoring, legal prohibitions, a greater degree of municipal enforcement and prosecutions, Extra-Strength Sewer Surcharges will contribute to an improved sewer use program in Ontario.

REFERENCES

- Anderson, N.E. and B. Sosewitz. 1971. "Chicago Industrial Waste surcharge Ordinance." *Journal of the Water Pollution Control Federation* 43(8):1591-1599.
- Anonymous. 1971. "Cities Treat Industrial Waste." *Environmental Science and Technology* 5(10):1000-1002.
- Bubis, N.S. 1963. "Industrial Waste Control in Metropolitan Winnipeg." *Journal of the Water Pollution Control Federation* 35(11):1403-1413.
- Donnan, J. and P. Victor. 1976. "Alternative Policies for Pollution Abatement: The Ontario Pulp and Paper Industry" Ontario Ministry of the Environment.
- Foess, G.W. and M.D. Mynhier. 1983. "Experiences with User Charge Litigation" presented at the 56th Annual Conference of the Water Pollution Control Federation, Atlanta, Georgia.
- Harkness, N. 1984. "Problems Associated with the Disposal of Trade Effluent to Sewers - Charging and Control." *Water Pollution Control* 83(3):367-375.
- Ingold, N.I. and N.G. Stonebridge. 1987. "Trade Effluent Charging - The Mogden Formula." *Water Pollution Control*. pp. 172-183.
- Kremer, J.G. and D. Glasgow. 1979. "Industrial Waste Surcharge Program in Los Angeles County." *Journal of the Water Pollution Control Federation* 51(11):2626-2635.
- Lake, E.E., W.M. Hanneman and S.M. Oster. 1979. Who Pays for Clean Water? The Distribution of Water Pollution Control Costs. Westview Press, Boulder, Colorado.

Mount, T.L. 1979. "A Municipal Program to Control Industrial Waste." Presented at American Institute of Plant Engineers Water Pollution Contamination Control Conference, New Jersey, April 10.

Olliffe, J.J. 1963. "Sewer Service Charges and Surcharges." Journal of the Water Pollution Control Federation 35(5):607-613.

Ontario Ministry of the Environment. 1987. "Economic Information Needs and Assessments for Developing MISA Monitoring and Abatement Requirements." Corporate Resources Division.

Pearse, P.H. F. Bertrand, and J.W. MacLaren. 1985. "Currents of Change." Final Report, Inquiry on Federal Water Policy, Ottawa.

Peat Marwick and Partners in association with W.A. Sims. 1983. Economic Incentive Policy Instruments to Implement Pollution Control Objectives in Ontario. Toronto: Peat Marwick and Partners.

Perman, A. 1974. "The Experience with the Effluent Charge Scheme of the City of Winnipeg." Presented to Department of the Environment, Hull, P.A., Reproduced in J. Donnan and P. Victor, 1976. "Alternative Policies for Pollution Abatement, The Ontario Pulp and Paper Industry." Vol. 2, Ontario Ministry of the Environment.

Public Works Engineer. 1955. "Industrial Waste Disposal Charges in Cities over 5,000 Population." Special Report no. 18-5, American Public Works Association.

Shaw, R.E. 1970. "Experience With Waste Ordinance and Surcharges at Greenboro, N.C." Journal of the Water Pollution Control Federation 42(1):44-50.

Sidwick, J.M. 1982. "The Discharge of Industrial Effluents to the Public Sewer." In Volume 1 of Water Resource Management in Industrial Areas, International Water Resources Association Report. pp 376-384.

Sims, W.A. 1979. "The Response of Firms to Pollution Charges." Canadian Journal of Economics, XII(1):57-74.

Taylor, C.C. 1972. "Industrial Waste Treatment Charges for Users as Required by the Environmental Protection Agency." The Georgia Operator. Spring.

Technical Practice Committee. 1982. "Sewer Charges for Wastewater Collection and Treatment - A Survey." Water Pollution Control Federation, Washington, D.C.



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